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## NOTE ON A GROWTH OF *SYNURA* IN LAKE COCHITUATE, MASSACHUSETTS.

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BY HORATIO NEWTON PARKER.

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In the *American Naturalist*, Vol. 33, No. 390, Page 485 (1899), G. C. Whipple and the writer described a growth of *Mallomonas* at the thermocline in Lake Cochituate, and later, in a paper "On the amount of Oxygen and Carbonic Acid Dissolved in natural waters and the Effect of These Gases Upon the Occurrence of Microscopic Organisms" (*Trans. Am. Microscopical Soc.*, Vol. 23, Pages 103-144, 1901), commented on the growth as follows (Page 140): "It will be seen that the organisms (*Mallomonas*) were concentrated just below the thermocline. From what is now known of the distribution of oxygen and carbonic acid in Lake Cochituate, the reason for this is at hand. At the surface and throughout the circulating water above the thermocline oxygen was abundant, but carbonic acid was absent. Near the bottom of the lake there was carbonic acid, but no oxygen, and likewise an insufficient amount of light for plant growth. But just below the thermocline there were both carbonic acid and oxygen, and as *Mallomonas* is a chlorophyl bearing organism, it found there favorable conditions for its development."

As being in line with these statements, it is desired to record here the observations that were made on a growth of *Synura* in Lake Cochituate in 1900. At that time the data were not available for publication, but they are now presented by permission of Dexter Brackett, Chief Engineer of the Metropolitan Water Board, and through the courtesy of A. W. Walker, Biologist of the Board.

The noteworthy facts are given in the accompanying table.

Temperature in degrees Fahrenheit and Synura in standard units per c.c. and free CO in parts per million at different depths in Lake Cochituate from August 6, 1900, to October 15, 1900:

Depth in ft.	Aug. 6	Aug. 13	Aug. 17	Aug. 20	Aug. 24	Sept. 4	Sept. 7	Sept. 10	Sept. 14	Sept. 17	Sept. 21	Sept. 24	Oct. 1	Oct. 8	Oct. 13	Oct. 15
Sur- face	Temp.	74°.5	Temp.	72°.8	Temp.	77°.0	Temp.	76.8	Temp.	71.4	Temp.	64.5	Temp.	64.3	Temp.	59.4
5	Synura	0	Synura	0	Synura	0	Synura	0	Synura	0	Synura	0	Synura	0	Free C.O.2	9.0
10	Temp.	76°.2	Temp.	72°.8	Temp.	77°.0	Temp.	75.1	Temp.	71.4	Temp.	64.5	Temp.	64.3	Temp.	59.4
15	Synura	0	Synura	0	Synura	0	Synura	0	Synura	0	Synura	0	Synura	0	Temp.	59.4
16	Temp.	76°.2	Temp.	72°.8	Temp.	77°.0	Temp.	74.8	Temp.	71.4	Temp.	64.5	Temp.	64.3	Temp.	59.4
17	Synura	188	Synura	188	Synura	84	Synura	66.7	Synura	67.7	Synura	0	Synura	64.1	Temp.	59.4
18	Temp.	76°.2	Temp.	72°.8	Temp.	77°.0	Temp.	68.4	Temp.	67.7	Temp.	64.5	Temp.	64.1	Temp.	59.4
19	Synura	88	Synura	88	Synura	61.6	Synura	60.9	Synura	54.6	Synura	44	Synura	56.5	Temp.	59.1
20	Temp.	76°.2	Temp.	72°.8	Temp.	77°.0	Temp.	55.4	Temp.	54.6	Temp.	59.8	Temp.	56.9	Temp.	58.3
21	Synura	0	Synura	0	Synura	55.7	Synura	58.7	Synura	58.7	Synura	30	Synura	50.5	Temp.	58.3
22	Temp.	76°.2	Temp.	72°.8	Temp.	77°.0	Temp.	52.2	Temp.	58.7	Temp.	59.8	Temp.	50.5	Temp.	58.6
23	Synura	0	Synura	0	Synura	50.3	Synura	50.7	Synura	50.7	Synura	0	Synura	50.5	Temp.	51.9
24	Temp.	76°.2	Temp.	72°.8	Temp.	77°.0	Temp.	50.2	Temp.	49.6	Temp.	50.7	Temp.	50.5	Temp.	50.6
25	Synura	80	Synura	80	Synura	48.5	Synura	49.1	Synura	48.4	Synura	0	Synura	48.9	Temp.	48.5
30	Temp.	56°.0	Temp.	51°.7	Temp.	47.1	Temp.	48.1	Temp.	47.1	Temp.	49.0	Temp.	47.3	Temp.	48.5
35	Synura	0	Synura	0	Synura	45.5	Synura	46.9	Synura	45.4	Synura	20	Synura	45.8	Temp.	47.4
40	Temp.	56°.0	Temp.	51°.7	Temp.	44.7	Temp.	44.5	Temp.	44.4	Temp.	46.1	Temp.	45.4	Temp.	46.1
45	Synura	20	Synura	20	Synura	43.7	Synura	43.7	Synura	43.6	Synura	0	Synura	44.5	Temp.	44.4
50	Temp.	56°.0	Temp.	51°.7	Temp.	43.7	Temp.	43.8	Temp.	43.6	Temp.	43.8	Temp.	43.7	Temp.	44.4
51	Synura	0	Synura	0	Synura	43.3	Synura	43.8	Synura	43.6	Synura	0	Synura	43.7	Temp.	43.8
52	Temp.	56°.0	Temp.	51°.7	Temp.	43.3	Temp.	43.8	Temp.	43.6	Temp.	43.7	Temp.	43.7	Temp.	43.8
53	Synura	20	Synura	20	Synura	0	Synura	43.6	Synura	43.6	Synura	0	Synura	43.7	Temp.	43.8
54	Temp.	56°.0	Temp.	51°.7	Temp.	43.3	Temp.	43.8	Temp.	43.6	Temp.	43.7	Temp.	43.7	Temp.	43.8
55	Synura	0	Synura	0	Synura	43.3	Synura	43.8	Synura	43.6	Synura	0	Synura	43.7	Temp.	43.8
56	Temp.	56°.0	Temp.	51°.7	Temp.	43.3	Temp.	43.8	Temp.	43.6	Temp.	43.7	Temp.	43.7	Temp.	43.8
57	Synura	0	Synura	0	Synura	43.3	Synura	43.8	Synura	43.6	Synura	0	Synura	43.7	Temp.	43.8
58	Temp.	56°.0	Temp.	51°.7	Temp.	43.3	Temp.	43.8	Temp.	43.6	Temp.	43.7	Temp.	43.7	Temp.	43.8
59	Synura	20	Synura	20	Synura	43.3	Synura	43.8	Synura	43.6	Synura	0	Synura	43.7	Temp.	43.8
60	Temp.	49°.4	Temp.	46°.3	Temp.	46°.3	Temp.	43.8	Temp.	43.6	Temp.	43.7	Temp.	43.7	Temp.	43.8
61	Synura	0	Synura	0	Synura	43.3	Synura	43.8	Synura	43.6	Synura	0	Synura	43.7	Temp.	43.8
62	Temp.	49°.4	Temp.	46°.3	Temp.	46°.3	Temp.	43.8	Temp.	43.6	Temp.	43.7	Temp.	43.7	Temp.	43.8

*Synura* appeared on August 6th and persisted through September 21st, after which date it was not found, though observations were continued until October 15th. At no time during the period was the organism discovered at a depth of less than fifteen feet and, though the *Synura* seems to have been scattered from mid-depth to the bottom, there never were found more than 40 standard units per c. c. in any sample taken at a depth greater than 30 feet. Between the depths of 15 and 30 feet *Synura* thrived, though the position of most vigorous growth appears to have been clearly defined at between 25 and 30 feet, for it was at these depths that the largest numbers were obtained. The temperatures prior to September 7th were taken with a thermometer and those obtained at 30 and 60 feet are undoubtedly high; yet they are sufficiently accurate to show that the lake was thermally stratified. On September 7th, and thereafter, the temperatures were taken with a thermaphone (The Microscopy Drinking Water, Whipple, 2d Ed., p. 54) and are accurate. It appears from the table that during the period the temperature of the water varied from a maximum of 77° 0 F. at the surface to a minimum of 43° 3 F. at the bottom, and that while the growth persisted the temperature of the surface to 10 foot stratum, wherein no *Synura* was found, was never less than 68° 0 F. The highest temperature at which a considerable quantity of *Synura* developed was 66° 5 F., the temperature of the 15-foot sample on September 7th and the lowest temperature at which the organism was found was 43° 6 F., the temperature of the 40-foot sample on September 10th. The temperature of the samples ranged from 48° 5 to 50° 8 F. at 25 and 30 feet, and, as it was at these depths that the greatest quantities of *Synura* were obtained, it may be that within these narrow limits the organism finds the temperatures that most favors its development. Temperature is not the only factor, however, that fostered the organism at this place in the vertical dimension, for at higher levels there would have been less free carbonic acid and at lower ones less oxygen and less sunlight, and all of these are essential to the organism. However, the observations that *Synura* at no time during this considerable summer growth was found at a temperature higher than 66° 5 F. and that it was most numerous at temperatures between 48° 5 F. and 50° 8 F., accord with the fact that in the colder

parts of the year, in late autumn, in winter and in early spring the organism most often develops in quantities large enough to impart its characteristic disagreeable odor of ripe cucumbers to large bodies of water. Moreover, the growth in Lake Cochituate throws light on those big summer growths of *Synura* that sometimes unexpectedly appear in public water supplies, infest them for a few days and suddenly die out; for it is quite possible that, as in Lake Cochituate, the organisms establish themselves in a favorable environment at a depth in the water and later by a high wind or some other agent are brought to the surface, where they soon succumb to lack of food and unfavorable temperature.

In studying this growth of *Synura*, free carbonic acid determinations ought to have been made, but it was not possible to do this prior to October 12th, at which date the organisms had entirely disappeared. However, from this single observation and the temperatures recorded, together with what is now known of the distribution of free carbonic acid in Lake Cochituate when it is thermally stratified, it seems reasonable that during the period of this growth of *Synura*, the free carbonic acid at 25 feet was about 9 parts per million, at 15 feet about 5 parts and at less depths, about 2.5 parts. Of course, in the absence of actual determinations, it is not certain that the free carbonic acid then was thus distributed, but to the writer it seems entirely probable that it was so.

What terminated this growth in Lake Cochituate is not apparent. At the time the *Synura* disappeared the temperature at 30 feet, where the growth had been largest, was unchanged (49° F.), and the supply of free carbonic acid was abundant; the only clue to the disappearance of the *Synura* is to be found in the temperature readings, which show that the surface waters were rapidly cooling. It may be the *Synura* swam away from its plentiful food supply of carbonic acid into the circulating cooling waters and thus perished.

Boston, Mass., March, 1911.